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Effects of Learning Agham Buddies (LAB) on the Conceptual Understanding of Matter among Fourth-Grade Pupils

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Abstract

The current curriculum places a strong emphasis on learner-centered, activity-driven, and collaborative approaches to teaching and learning, particularly in the field of science. This action research aimed to investigate the impact of employing Learning Agham Buddies (LAB) on the conceptual understanding of matter among fourth-grade Science pupils. The study included 26 students from the experimental group (Grade IV Matikas) and 26 from the control group (Grade IV Mayumi) in a state-run elementary school in Zambales, Philippines. To assess the effectiveness of this intervention, both pre-tests and post-tests were administered before and after implementing LAB. The collected data included students' written work and performance tasks, which were analyzed to gauge improvements in their understanding of the topic. The results revealed a significant difference in conceptual understanding between the experimental and control groups, with LAB demonstrating a higher gain score (14.77) compared to traditional learning (11.81). This study recommends the adoption of LAB, a collaborative learning strategy, to enhance science students' conceptual understanding.

Keywords: Action Research, Learning Agham Buddies (LAB), Philippines, Science Teaching, Teaching Strategy

INTRODUCTION

Technology has become a powerful tool for exploring and discovering new scientific concepts, making the teaching of science a resource-intensive process (Macanas & Rogayan, 2019). Teaching Science require a lot of energy, resources and time. However, with the different innovative teaching strategies, an intricacy of teaching Science is no longer a problem.

Collaborative learning, a pedagogical approach that has gained increasing prominence in educational discourse, represents a paradigm shift in the way knowledge is acquired and assimilated in contemporary learning environments. Rooted in the principles of social constructivism, collaborative learning emphasizes the active engagement of students in group activities and interactions, creating a dynamic and interactive learning experience (Er et al., 2021; Ferreira, 2021; Herrera-Pavo, 2021; Kaliisa et al., 2022). This approach stands in contrast to traditional didactic methods, where knowledge transmission occurs primarily from instructor to student.

Furthermore, collaborative learning underlying philosophy is founded on the belief that learning is a social and collaborative endeavor, where students, in a cooperative setting, construct knowledge, share insights, and jointly seek solutions to complex problems. In this process, they not only acquire subject-specific content but also develop essential skills, such as communication, critical thinking, and teamwork, that are highly valued in the modern workforce. Several researches confirmed the effectiveness of collaborative learning specifically in science teaching (Erbil, 2020; Jeong et al., 2019; Supena et al., 2021).

In this action research project, we customized a collaborative learning strategy called Learning Agham Buddies (LAB) which is based from the well-tested cooperative learning. *'Agham'* is a Filipino term for science, and LAB literally means learning buddy or learning partner in science. The LAB strategy is a learner-centered instructional technique that instructors may employ to facilitate the teaching-learning process in science. In the framework of LAB, the educational method puts students firmly at the center of the teaching-learning experience. This implies that pupils actively participate in their own learning. Within this framework, students participate in collaborative activities and exercises that are especially intended to support the educational process (Hsu et al., 2022; Mora et al., 2020). These activities are designed to encourage student engagement, discussion, and innovative thinking, with an emphasis on group dynamics and peer learning. The LAB technique may be used to improve learners' conceptual knowledge and promote higher-order thinking abilities such as critical and creative thinking.

What differentiates LAB is the degree of autonomy and self-direction it provides to learners. They are encouraged to collaborate on given educational activities with little monitoring and interference from their teacher (Arinaitwe, 2021; Han et al., 2021). This aspect of the approach empowers students to take ownership of their learning, pushing them to become more autonomous and independent in the process. It substitutes the traditional teacher-centric approach with a more student-centered one in which students actively participate in building their own understanding of the subject. As a consequence, we sought to evaluate the effectiveness of this learning strategy in boosting scientific students' conceptual knowledge.

Conceptual understanding is a greater degree of insight and knowledge that goes beyond memorizing or rote learning. It entails understanding the basic principles, underlying concepts, and interconnections of ideas within a certain topic or area, such as science. It enables individuals to not only differentiate facts or information, but also grasp how those things connect to one another and to greater concepts (Al-Muyawah et al., 2019; Dewi, & Primayana, 2019; Hottecke & Alchin, 2020). It allows students to apply their knowledge in new and varied settings, solve complicated issues, and draw meaningful connections between ideas. The capacity of children to acquire conceptual knowledge, which allows them to grasp concepts in ways that may be applied in a variety of circumstances, is presently an issue of concern in education (Omari & Chen, 2016). This change in focus stems from the understanding that memory and traditional teaching approaches are increasingly considered as insufficient for educating students to successfully apply their information in practical, real-world settings (Omari & Chen, 2016).

The use of LAB strategy requires students to work in groups and address the deficiencies of the other members of the group, allowing them to shift their perception of science as a difficult subject. Through LAB, their conceptual knowledge is expected to be improved, and their misconceptions about science can be addressed.

Conceptual Framework

The dynamic nature of collaborative learning creates an inclusive classroom atmosphere in which students from all backgrounds and skills may actively engage and contribute. This inclusion encourages a more diverse interchange of opinions and ideas, which improves the overall learning experience. Furthermore, the integration of technology and online platforms has increased the possibilities for collaborative learning by breaking down physical barriers and allowing remote cooperation, which is increasingly vital in today's globalized and digitalized society.

The first step of the research, known as the pre-intervention stage, tests Science students' conceptual comprehension of the topic before any treatment is administered. The next phase includes two separate treatments: the control group is instructed using the standard approach (TMI), while the experimental group is exposed to the LAB. The end result is the degree of conceptual understanding of the issue among students in both the control and experimental groups.

Purpose of the Study

This study aimed to determine the effectiveness of Learning Agham Buddies (LAB) in improving the conceptual understanding on matter of the Science IV pupils.

METHOD

Research Design

In this research, we utilized a quasi-experimental action research with two distinct groups. The control group received instruction through conventional teaching methods, while the experimental group was taught using the Learning Agham Buddies (LAB) approach. Quasi-experimental action research is often employed in educational settings when researchers or teacher-practitioners want to explore the effect of interventions or changes in real-world scenarios without the precise control required for experimental research. It tries to provide practical insights and solutions to particular problems or situations.

Participants

We selected a cohort of 52 Grade IV pupils to serve as the study's participants. These participants were divided into two distinct groups: a control group and an experimental group, each comprising 26 pupils. The purpose of having two groups is to enable a comparative analysis of the impact of different teaching interventions.

Data Collection Tool

To collect data for assessing the impact of LAB on Science IV students, both pre-test and post-test were conducted. These 40-item tests were designed to gauge the students' level of conceptual understanding concerning matter in Science IV. The study specifically focused on the Properties of Matter, a subject addressed during the first quarter of Science IV. By the end of the instructional unit, students were expected to showcase their comprehension of grouping various materials based on their distinct properties and their ability to recognize the transformations that materials undergo when subjected to specific conditions. The researchers prepared a table of specifications (TOS) for the 40-item matter test based on the K12 Curriculum Guide. The test gauged the following learning outcomes: classify materials based on the ability to absorb water (6 items); identify the effect of decaying materials on one's health and safety (6 items), distinguish safety precautions in disposing waste materials (6 items), recognize the materials that has ability to float and sink (1 item), identify the importance of product labels (1 item), identify changes of properties when exposed to different temperature (1 item), distinguish what happened to the solid materials when mixed with liquid materials (6 items), identify what happen to the liquid when mixed with another liquid (1 item), identify changes in materials that are useful and harmful in one's environment (2 items), identify what happened when solid materials mixed with another solid (5 items), and distinguish the changes of materials that undergo (5 items).

The test was validated by three science teachers in terms of content validity. The test was pilot-tested and an item analysis was done to ensure the reliability of the test. Comments and suggestions of the experts were considered in the finalization of the test.

Study Context

The study was conducted in a state-run elementary school in Zambales, Philippines. We involved an intact class in the said school. The study was conducted prior to the COVID-19 pandemic wherein the learning modality is face-to-face in-person class.

Data Collection

The study commenced with a pre-test administered at the beginning of the lesson, aimed at assessing the class's initial conceptual understanding of the subject matter before implementing the instructional technique. Conversely, a post-test was conducted at the conclusion of the study to evaluate the extent to which the aforementioned technique contributed to enhancing the level of conceptual understanding concerning the subject matter. Both the pre-test and post-test consisted of a total of 40 items.

The pre-test, administered before initiating the unit, served the purpose of identifying areas of weakness among the students in their grasp of the topic which is about matter. Moreover, the outcomes of the pre-test played a key role in determining the composition of the experimental group, facilitating the grouping process. On the other hand, the post-test was administered to the pupils upon completing the unit, assessing the extent of improvement in their conceptual understanding following their exposure to the Learning Agham Buddies (LAB) approach.

The Learning Agham Buddies (LAB), operating as a collaborative learning strategy, places a strong emphasis on being pupil-centered and activity-based. The experimental group adhered to the subsequent steps:

Engaging Start. The teacher captivated her students' interest by employing a range of motivational activities, including the utilization of video clips, images, musical elements, and stimulating questions.

Get the Directions. Prior to commencing the main activity, the teacher conducted a pre-activity discussion during which the students attentively received instructions regarding the tasks of the day.

Agham Task. Various Agham learning groups engaged in collaborative work with their respective Agham partners, addressing distinct Agham (science) tasks. These tasks centered around the concept of matter, encompassing its properties and the transformations that materials undergo.

Sharing Time. Selected presenters from each Agham learning group showcased their individual outcomes. Subsequently, the teacher conducted an assessment and critique of the presentations by applying rubrics.

Conceptual Understanding Check. The learners' comprehension of the day's material is assessed through check-up quizzes and various written activities.

In contrast to the traditional teaching strategy, in which teachers function mainly as lecturers and major sources of information, the LAB intervention emphasizes experiential learning for students. Rather of just communicating existing information or providing a direct path to knowledge, LAB invites learners to actively interact with the topic. This technique not only broadens pupils' mental comprehension but also improves their interpersonal abilities. The use of LAB as a primary teaching technique pushed the researchers to use a variety of resources to support a more successful learning experience. These resources included visual pictures and real items, which helped to create a more interesting and effective learning environment.

Data Analysis

In evaluating the impact of the TMI and LAB approach, we involved a multifaceted data analysis strategy. This includes item analysis to assess test item difficulty and establish test validity, frequency distribution for result summarization, mean comparison to measure changes in class performance before and after the study, dependent t-tests to determine the statistical significance of score differences, and standard deviation to assess the dispersion of class performance. These methods collectively provided a comprehensive perspective on the effects of LAB on students' conceptual understanding in the subject matter. The researcher also evaluated the pupil's conceptual understanding by using various formative assessments.

RESULTS AND DISCUSSION

Pupils' Level of Conceptual Understanding on Matter before the Treatment

The outcomes of the pre-test established the baseline for the students' conceptual comprehension in both the control and experimental groups before the introduction of the LAB approach (Table 1).

Table 1. Level of Conceptual Understanding of Pupils before the Treatment

Pre-Test Scores	Control Group		Experimental Group	
	Frequency (n=26)	Percent (100.00)	Frequency (n=26)	Percent (100.00)
17-24	8	30.77	2	7.69
9-16	15	57.69	23	88.46
1-8	3	11.54	1	3.85
Average	13.73 (Fairly Satisfactory) sd = 3.82		12.50 (Fairly Satisfactory) sd = 2.75	

The pre-test results for the control group indicated that their performance level in terms of conceptual understanding was categorized as "fairly satisfactory," with a weighted mean of 13.73 (SD = 3.82). Majority of the test scores fell within the range of 9 to 16 out of the 40-item Science test. Conversely, the experimental group's pre-test results also fell within the "fairly satisfactory" category, with a weighted mean of 12.50 (SD = 2.75). Most of the students in this group obtained scores in the range of 9 to 16 out of the 40-item test.

The findings suggest that prior to any instructional changes, both groups had a reasonably equal level of understanding of the topic, with the majority of students doing satisfactorily. The standard deviations show that the scores varied within each group, although the overall performance levels were similar.

It is worth noting that before the LAB intervention, both groups had rather poor levels of conceptual comprehension, as demonstrated by their weighted average scores. Furthermore, the experimental group's pre-test performance was somewhat worse than the control group.

Collaborative learning promotes deeper understanding of scientific concepts by encouraging active participation, discussions, peer teaching, problem-solving, and immediate feedback. It leverages social interaction and diverse perspectives to create a dynamic learning environment where students can explore and apply scientific knowledge in a meaningful way (Chen et al., 2021; Davidson, 2021; Yakob et al., 2023).

The researchers also assessed the proficiency levels of students in various subskills related to their conceptual understanding (Table 2).

Table 2. Pupils' Level of Proficiency in the Different Sub-skills of Conceptual Understanding prior the Treatment

Sub-skills	Control Group		Experimental Group	
	Number of Pupils (n=26)	Percent (%)	Number of Pupils (n=26)	Percent (%)
Concepts and Content Knowledge	8	30.77	9	34.62
Depth within Topics	7	26.92	6	23.08
Transfer and Connections	7	26.92	5	19.23
Weighted Mean	7	26.92	7	26.92

Before the intervention, the students in the control group exhibited a proficiency level of only 26.92% in terms of conceptual understanding. This implies that out of the 26 students, only 7 were able to excel in all the sub-skills related to conceptual understanding. Among these sub-skills, the highest performance was observed in "Concepts and Content Knowledge," with a class performance of 30.77%. Similarly, the experimental group also demonstrated a 26.92% class performance in conceptual understanding before the intervention. Once again, the sub-skill with the highest performance was "Concepts and Content Knowledge," achieving a class performance of 34.62%.

These findings suggest that prior to the intervention, only a minority of students were proficient in the various sub-skills associated with conceptual understanding. Students faced challenges in delving deeply into topics and in applying transfer and connection skills. Additionally, only a limited number of students possessed a strong grasp of concepts and content knowledge before the treatment, regardless of whether they were in the control or experimental group. While the majority of students were not performing at an advanced level in all aspects, Concepts and Content Knowledge appeared to be the sub-skill where students had relatively higher proficiency.

Promoting conceptual understanding is considered essential because it helps students acquire a more enduring comprehension of the subject matter. Rather than just memorizing facts and figures, students with strong conceptual understanding can explain why things work the way they do and can transfer their knowledge to novel scenarios (Fries et al, 2021; Hobbins et al., 2020; Stern et al., 2021).

Pupils' Level of Conceptual Understanding on Matter after the Treatment

To evaluate the efficacy of the strategies used, a post-test was conducted (Table 3). In the post-test results, it was evident that none of the students in either the control or experimental group fell into the "Did Not Meet Expectations" or "Fairly Satisfactory" performance levels.

Table 3. Level of Conceptual Understanding of Pupils after the Treatment

Post-Test Scores	Control Group		Experimental Group	
	Frequency (n=26)	Percent (100.00)	Frequency (n=26)	Percent (100.00)
33-40	0	0	4	15.38
25-32	18	69.23	16	61.54
17-24	8	30.77	6	23.08
Average	25.54 (Very Satisfactory) sd = 2.92		27.27 (Very Satisfactory) sd = 3.80	

Legend: 33-40 (Outstanding); 25-32 (Very Satisfactory); 17-24 (Satisfactory); 9-16 (Fairly Satisfactory); 1-8 (Did Not Meet Expectations)

In the control group's post-test, the majority of test scores clustered in the range of 25 to 32, with 18 pupils (69.23%) achieving scores in this bracket. This performance led to a weighted mean of 25.54, classifying the control group as "Very Satisfactory" after the implementation of the traditional teaching method.

In contrast, the post-test results for the experimental group indicated that the majority of test scores also fell within the range of 25 to 32, with 16 pupils (61.54%) achieving scores in this bracket. Notably, four pupils (15.38%) were classified as "Outstanding" after their exposure to the LAB approach.

These findings demonstrate the impact of the respective teaching methods on student performance. The TMI resulted in a "Very Satisfactory" level for the control group, while the LAB approach led to "Outstanding" performance in some students within the experimental group.

Collaborative learning is effective in science teaching as it enhances learners' critical thinking skills (Warsah et al., 2021), fosters student motivation (Tran, 2019), improves student learning outcomes (Supena et al., 2021) and encourages collaboration (Nahar, 2022).

The researcher also determined the level of proficiency of pupils in the different subskills of conceptual understanding of pupils after the treatment (Table 4).

Table 4. Pupils' Level of Proficiency in the Different Subskills of Conceptual Understanding after the Treatment

Sub-skills	Control Group		Experimental Group	
	Number of Pupils (n=26)	Percent (%)	Number of Pupils (n=26)	Percent (%)
Concepts and Content Knowledge	16	61.54	20	76.92
Depth within Topics	17	65.38	19	73.08
Transfer and Connections	19	73.08	23	88.46
Weighted Mean	17	65.38	21	80.77

Following the intervention, the students in the control group demonstrated a proficiency level of 65.38% in terms of their conceptual understanding. This means that 17 out of 26 pupils were able to excel in all the sub-skills related to conceptual understanding. Notably, the Transfer and Connections sub-skill exhibited the highest performance, with 19 pupils (73.08%) mastering it. In contrast, the experimental group achieved a class performance of 80.77% in terms of conceptual understanding after the intervention. The Transfer and Connections sub-skill remained the top-performing sub-skill, with 23 pupils, or 88.46% of the class, showing proficiency in this area.

These results suggest that, following the intervention, a significant improvement was observed in both groups, with most pupils displaying competence in various sub-skills related to conceptual understanding. It is noteworthy that the Transfer and Connections sub-skill, which emphasizes the application of scientific knowledge to real-life situations, saw significant enhancements. This underscores the central objective of science education, which is to make learning relevant, meaningful, and applicable to everyday life.

In contemporary science education, the acquisition of knowledge transcends the mere memorization of facts and theories. A holistic understanding of science involves the ability to apply acquired knowledge, engage in critical thinking, and make connections across diverse scientific domains (Bao, & Koenig, 2019; Valladares, 2021). Collaborative learning, with its emphasis on active engagement, peer interaction, and problem-solving, aligns seamlessly with these educational objectives.

Difference in the Conceptual Understanding on Matter prior and after the Treatment

In order to assess the notable differences following the implementation of the teaching strategy, the mean difference between the scores in the pretest and posttest for both the control and experimental groups is presented (Table 5).

in the control group, the Science IV class achieved a mean gain score of 11.81, calculated by subtracting the pretest score of 13.73 from the posttest score of 25.54. Utilizing the paired-samples t-test, a t-value of 23.36 was computed, with a p-value of 0.0000, indicating a substantial and significant difference in the students' level of conceptual understanding in the subject matter after traditional teaching.

Conversely, in the experimental group, a higher gain score of 14.77 was observed. This gain score was derived from the post-test score of 27.77 and the pretest score of 12.50. The paired-samples t-test obtained a t-value of 28.83, and the associated p-value was 0.0000. These results imply a significant difference in the level of conceptual understanding among students after the implementation of the Learning Agham Buddies (LAB) approach.

While both the control and experimental groups showed substantial gains in conceptual understanding, the experimental group that used the LAB technique had a higher gain score. The paired-samples t-tests for both groups had surprisingly low p-values, indicating that their distinct teaching strategies had a significant influence on students' understanding.

Collaborative learning allows pupils to experience additional thoughts and opinions. Science is a subject that is always developing, with new findings and concepts arising (Mohan & Kelly, 2020). Collaborative environments are ideal for exchanging ideas and exploring various approaches to scientific problems (Young & Freytag, 2021).

Table 5. T-test of the Pretest and Posttest Mean Gain of the Control and Experimental Groups in the Science Test

Group	Posttest Mean	Pretest Mean	Gain Score	*t*-value	*p*-value	Remarks
Control	25.54	13.73	11.81	23.36	0.0000	Sig.
Experimental	27.27	12.50	14.77	28.83	0.0000	Sig.

Observed Pupils' Behavior in the Control and Experimental Groups after the Treatment

Based on our observations, it is apparent that the pupils in the control group tend to be passive learners. They primarily adopt a receptive role, listening as the teacher imparts the concepts related to the subject matter. Their learning style leans more towards a teacher-student dynamic rather than encouraging peer-to-peer interactions. In contrast, we observed that the learners in the experimental group, who are exposed to the Learning Agham Buddies (LAB) approach, exhibit a higher level of activity and engagement in the learning process. They actively participate in discussions, displaying increased interpersonal interactions. Moreover, they demonstrate a collaborative and cooperative spirit with their fellow agham buddies. Learning, in this context, extends beyond the classroom, manifesting through ongoing interactions among the pupils within their learning agham buddy groups.

As we examine the observed pupils' behavior in both the control and experimental groups post-treatment, we found out striking disparities in their engagement and learning dynamics. Our keen observations shed light on these differences which allowed us to have a comprehensive comparative analysis with existing research in the field.

Learners in the control group have a strong tendency toward passivity. This is consistent with previous research, which often describes traditional teaching methodologies as promoting a more passive learning environment (Chang & Hwang, 2023). In contrast, the experimental group, which was immersed in the LAB method, exhibited a significantly different behavioral landscape. This is consistent with collaborative learning research, which highlights the value of peer involvement and active participation in promoting deeper comprehension and information retention (Forster et al., 2022).

Furthermore, the collaborative and cooperative attitude displayed by the experimental group differs significantly from the more individualistic approach found in the control group. The formation of learning agham buddy groups helps to create an atmosphere in which students cooperatively explore the subject matter, expanding their learning beyond the classroom setting. This conclusion is consistent with the broader research on collaborative learning, which emphasizes its importance not just in information acquisition but also in developing a feeling of community and shared responsibility for learning outcomes (Jarvela et al., 2021).

These findings are even more significant when viewed in light of current educational demands. Collaborative learning, as shown by the LAB method, emerges as an effective teaching tool. The observed favorable attitudes toward learning in the experimental group are consistent with previous studies demonstrating the advantages of collaborative learning for student motivation and academic achievement (Vergara et al., 2020; Warsah et al., 2021).

Collaborative learning not only fosters discussions, but it also allows students to take control of their own learning path. It motivates children to take more responsibility for their educational advancement. since a result, collaborative learning is especially important for today's kids, since it helps to establish positive attitudes about learning (Law et al., 2017).

CONCLUSION

In this present study, we looked into the effects of Learning Agham Buddies (LAB) on the pupils' conceptual understanding on matter. Prior to the treatment, Science learners in both the control and experimental groups performed well in terms of conceptual understanding. Following the treatment, the students' conceptual understanding and sub-skills in both the control and experimental groups increased to a very satisfactory level. This favorable change in their performance indicates a substantial difference in conceptual comprehension between the Science learners in both groups. However, the group that used the LAB technique earned a higher mean gain score, showing its efficacy in improving students' conceptual understanding. Learners in the experimental group were more active and engaged in the learning process, as well as having more interpersonal contacts. They showed a stronger willingness to work and cooperate with their agham buddies. Meanwhile, pupils in the control group had a more passive and less participatory approach to learning.

We recommend to encourage the incorporation of collaborative learning strategies in science education to enhance students' conceptual understanding. Collaborative methods, such as the Learning Agham Buddies (LAB) approach, have shown effectiveness in promoting active engagement and improved learning outcomes. We also suggest that professional development and training opportunities be provided for educators to equip them with the knowledge and skills needed to implement collaborative learning effectively. This may help teachers create a more collaborative and stimulating learning environment. We also see a need for frequent formative evaluations to track pupils' development and highlight areas for improvement. Ongoing assessment enables timely modifications in teaching approaches to meet students' requirements. Encourage teachers to create a climate that fosters active learning via conversations, group activities, and hands-on experimentation. This method may improve student involvement and intellectual comprehension. Emphasize the role of group dynamics and human interactions in the learning process. Encourage students to communicate, debate ideas, and complete tasks together to improve their conceptual grasp. Support more study on the long-term benefits of collaborative learning on students' academic development and employment prospects.

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